Sex difference in open-water ultra-swim performance in the longest Freswater Lake swim in Europe: Sex difference in ultra-swimming

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Abstract: ABSTRACT: This study examined participation and performance trends in the 26.4-km open-water ultra-swim 'Marathon Swim in Lake Zurich', Switzerland. A total of 461 athletes (157 females and 304 males) finished the race between 1987 and 2011. The mean age of the finishers during the studied period was 32.0±6.5 years for males and 30.9±7.2 years for females, respectively. The mean age of finishers and the age of winners increased significantly across years for both sexes ($p < 0.01$). The winner times were significantly lower for males (403±43 min) compared to females (452±63 min) ($p < 0.01$). In contrast, the mean swimming time of the finishers did not differ between males (530±39 min) and females (567±71 min) ($p > 0.05$). The swimming time performance remained stable ($p > 0.05$) for both sexes across years. A higher age was associated with an increased risk for not finishing the race (odds ratio = 0.93, $p = 0.045$). Swim time was negatively associated with water temperature in the top three swimmers (ß = -9.87, $p = 0.025$). These results show that open-water ultra-swimming performance of elite swimmers over 26.4 km in a freshwater lake is affected by age, sex and water temperature. The sex difference in open-water ultra-swimming performance (~11.5%) remained unchanged these last 25 years. It seems unlikely that elite female swimmers will achieve the same performance of elite male swimmers competing in open-water ultra-swimming in water of ~20℃. Anthropometric and physiological characteristics such as skeletal muscle mass and thermoregulation need additional investigations in female and male open-water ultra-swimmers.

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SEX DIFFERENCE IN OPEN-WATER ULTRA-SWIM PERFORMANCE IN THE LONGEST FRESWATER LAKE SWIM IN EUROPE

Sex difference in ultra-swimming

ABSTRACT

This study examined participation and performance trends in the 26.4-km open-water ultra-swim 'Marathon Swim in Lake Zurich', Switzerland. A total of 461 athletes (157 females and 304 males) finished the race between 1987 and 2011. The mean age of the finishers during the studied period was 32.0±6.5 years for males and 30.9±7.2 years for females, respectively. The mean age of finishers and the age of winners increased significantly across years for both sexes ($p < 0.01$). The winner times were significantly lower for males (403±43 min) compared to females (452±63 min) ($p < 0.01$). In contrast, the mean swimming time of the finishers did not differ between males (530±39 min) and females (567±71 min) ($p > 0.05$). The swimming time performance remained stable ($p > 0.05$) for both sexes across years. A higher age was associated with an increased risk for not finishing the race (odds ratio = 0.93, $p = 0.045$). Swim time was negatively associated with water temperature in the top three swimmers ($\beta = -9.87$, $p = 0.025$). These results show that open-water ultra-swimming performance of elite swimmers over 26.4 km in a freshwater lake is affected by age, sex and water temperature. The sex difference in open-water ultra-swimming performance (~11.5%) remained unchanged these last 25 years. It seems unlikely that elite female swimmers will achieve the same performance of elite male swimmers competing in open-water ultra-swimming in water of ~20°C. Anthropometric and physiological characteristics such as skeletal muscle mass and thermoregulation need additional investigations in female and male open-water ultra-swimmers.

Keywords: male, female, swimmer, athlete, ultra-endurance

INTRODUCTION

In recent years, several studies investigated the participation and performance trends in different ultra-endurance performances (> 6 hours) such as single sports disciplines like indoor ultra-swimming (3), ultra-running (7, 17), ultra-cycling (6, 15), inline skating (16) and multi-sports disciplines such as duathlon (28) and triathlon over the Ironman distance (19-21) and triathlon races longer than the Ironman distance (14, 27). Although one study investigated participation and performance trends in indoor ultra-endurance swimmers (3), data on participation and performance trends in open-water ultra-endurance swimming are missing.

The participation in ultra-endurance events generally increased since the first event of an ultra-endurance race was held (3, 7, 19). For example, in the 161-km 'Western States Endurance Run', the number of participants increased exponentially between 1977 and 2008 (7). At the 'Ironman Hawaii', Lepers reported an increased participation for 1981 to 2007 (19). In contrast, Knechtle et al. showed during the last years a plateau in participation for ultra-triathlons longer than an Ironman triathlon (14).

In the field of ultra-endurance events, little is known about open-water ultra-swimming (9-12, 23, 32). Most of these studies examined the relationship between anthropometric characteristics and ultra-swimming performance (10, 11, 13). It has been shown that anthropometric characteristics of male swimmers were not related to ultra-endurance performance in a 12-hours indoor swim race (13). In an open-water ultra-swim race, for females, race performance was not correlated to anthropometric factors, whereas for males, specific anthropometric characteristics such as the length of arms, body mass and body height were bi-variately associated with race performance (10). Open-water swimmers seem to be different compared to pool swimmers regarding anthropometry and physiology. Elite open-water swimmers were smaller and lighter compared to competitive pool swimmers. They possess aerobic metabolic alterations that resulted in an enhanced performance in long-distance swimming (33).

Regarding the sex difference in swimming performances, female pool swimmers were ~11% slower than males in swimming events at the Olympic Games 2000 (32). Similarly, the sex difference in a 3.8 km open-water swimming performance at the 'Waikiki Roughwater Swim' in Honolulu and at the 'Ironman Hawaii' triathlon was close to 9-10% (19). The difference in swim performance between male and female might be explained by several factors such as energy expenditure, anthropometric and physiological characteristics (30). The specific female physiology and anthropometry may be a greater advantage in long-distance compared to short-distance swimming. To date, no study investigated the sex difference in open-water ultra-endurance swimmers.

In this context, the aims of the present study were to investigate (*i*) the participation and performance trends, and (*ii*) the sex difference at the 'Marathon Swim in Lake Zurich', Switzerland, from 1987 to 2011. The 'Marathon Swim in Lake Zurich' in Switzerland is the longest open-water lake-swimming event in Europe with a distance of 26.4 km. This swimming event is of interest because of the large data pool available over 23 years and a lot of swimmers use this race as a preparation to the 'English Channel Swimming'. We hypothesized that during the studied period (*i*) the participation of ultra-swimmers would increase, (*ii*) the open-water ultra- swimmers would improve their performance and (*iii*) the sex difference in ultra-swimming performance would be smaller compared to those generally observed for conventional shorter swimming events.

METHODS

Experimental Approach to the Problem

The ‘Marathon Swim in Lake Zurich’ takes place in the Lake of Zurich in Switzerland at the beginning of August. The swimmers start at 7:00 a.m. from Rapperswil and have to cross the length of the lake and finish in Zurich. The race covers a distance of 26.4 km where the cut-off time is 12 hours. The swimmers must be accompanied by a support boat. Water temperature of Lake Zurich for all editions was provided by ‘Amt für Abfall, Wasser, Energie und Luft’ of Zurich (www.awel.zh.ch). The temperature was measured below the surface of the lake. Air temperature was provided by ‘MeteoSchweiz’ (www.meteoschweiz.admin.ch). The swimmers were allowed to grease their bodies. The use of high-tech swimsuits and additional floating devices was prohibited. The swimmers have to organize their own nutrition and helpers during the race. The race results and the age of the participants were available on the web site of the race (http://ch.srichinmoyraces.org). The study was approved by the Institutional Review Board of St. Gallen, Switzerland, with waiver of the requirement for informed consent given that the study involved the analysis of publicly available data.

Data analysis

The time performances in minutes and the age of both the male and female swimmers finishing the open water ‘Marathon Swim in Lake Zurich’ between 1987 and 2011 were analysed. The magnitude of sex difference was examined by calculating the percent difference for the swimming times between male and female winners.

Statistical analyses

Data were reported as means ± standard deviation (SD) within the text. Linear regressions were used for estimating the changes of selected variables per year. Pearson's correlation coefficients were used to assess the association between various variables (Statsoft, Version 6.1, Statistica, Tulsa, OK, USA). The mean age and the swimming time of the male and female winners during the 1987-2011 period were compared with a Student's *t*-test. The association between performance and athletes characteristics (*i.e.* age, sex) taking into account environmental factors (*i.e.* water temperature) was further investigated. To account for potential clustering between time periods, we performed a multilevel hierarchical regression analysis including race year as cluster variable. We calculated Intraclass Correlation Coefficients (ICCs) to estimate the variance that can be explained on the cluster level (*i.e.* race year). ICCs were calculated with variance of the race year/total variance x 100. Athletes were stratified according to their ranking (*i.e.* top three athletes of every year versus others) to further investigate differences of age, sex and water temperature on race performance with regard to the ranking of the athletes. The association between finishing the race and athletes and environmental factors was investigated using multilevel logistic regression analysis. Statistical significance was accepted at $p < 0.05$.

RESULTS

From 1987 to 2011, a total of 522 swimmers, 174 females (33.3%) and 348 males (66.7%), respectively, attempted to finish the 'Marathon Swim in Lake Zurich'. Among the starters, 461 swimmers (88.3%) reached the finish line, thereof 157 females (27.1%) and 304 males (65.9%). A total of 44 males (12.6% of male starters) and 17 females (9.8% of female starters) were not able to finish the race. The number of finishers increased significantly ($p < 0.001$) over the studied time (Figure 1). Between 1987 and 2011, the average number of finishers per year was 13±6 [range: 4-26] for males and 7±4 [range: 0-16] for females, respectively. Females accounted on average for 32±14% of the field over the 23-years period.

The mean age of both male and female winners did not significantly differ between each other during the 1987-2011 period (males: 26.8±9.5 years; females: 27.7±8.2 years, respectively) (Figure 2A). The age of both female and male winners increased significantly across the years. The mean age of the finishers during the studied period was 32.0±6.5 years for males and 30.9±7.2 years for females, respectively. The mean age of the finishers during the 1987-2011 period increased significantly across the years for both sexes (Figure 2B).

The 26-km swimming time of male winners was significantly faster than the time of female winners (males: 403±43 min, females: 452±63 min, respectively) ($p < 0.01$), but did not significantly change across the years for both sexes (Figure 3A) ($p > 0.05$). The 26-km swimming time of the finishers for both sexes is shown in Figure 3B. The 26-km swimming time of the finishers was 530±39 min for males, and 567±71 min for females, respectively. As for the winners, the mean swimming time of all finishers did not significantly change during the 1987-2011 period ($p > 0.05$).

The difference between the male and the female swimming record at the 'Marathon Swim in Lake Zurich' was equal to 2.3% (Table 1). The mean sex difference in swimming time for winners during the 1987-2011 period was 11.5±11.6% [range: 0-49%].

The effect of sex, age and water temperature on swim performance was investigated using multilevel regression analysis and mixed-effect logistic regression analysis. The results of the multilevel regression analysis are presented in Table 3 for all finishers (Model 1), for the top three swimmers (Model 2a), and the swimmers ranked behind the top three swimmers (Model 2b). For all finishers (Model 1), sex and age were significantly associated with race performance with a significant cluster effect (race year). However, the ICC was low at 7.3%. For the top three swimmers (Model 2a), age and sex were still associated with performance. In addition, water temperature was significantly and negatively associated with performance. ICC increased to 31%. For all finishers ranked behind the top three swimmers, sex was still associated with performance whereas age and water temperature were not related to performance. Race year showed a considerably lower influence on performance compared to the top three swimmers.

The results of the mixed-effect logistic regression analysis including all participants are presented in Table 4. Increasing age was associated with an increased risk for non-finishing the race. The race year affected significantly the chance of finishing the race (ICC 38%). Sex and water temperature were not associated with finishing the race.

DISCUSSION

A first important finding was that participation at the ‘Marathon Swim in Lake Zurich’ increased for both females and males from 1987 to 2011. The number of finishers in the ‘Marathon Swim in Lake Zurich’ increased over the 23-years period where females represented 32±14% of all finishers. This percentage is relatively high compared to other ultra-endurance races. By comparison, female participation in ultra-marathon running increased from none to 20% in a 161-km ultra-marathon between the 1970s and 2004 (7). Further, the participation of females in a 161-km ultra-marathon (20%) was low when compared to road races (49%) and marathons (40%) (7). At the ‘Ironman Hawaii’, the number of female participants increased from none in 1978, one in 1979 to 27% of the 1,700 athletes in 2007 (19).

A reason for the increase in female participation in ultra-endurance races could be that female athletes were not allowed to participate in the beginning of the ultra-endurance races (24). It was a common belief that females were physiologically not able to sustain an ultra-endurance race (24). So their participation rate is increasing now like the participation of male athletes did in earlier times. Another explanation for the increased female participation could be that the athletic population becomes older and therefore the age when female athletes obtain the menopause increased (2). The correlated decrease in bone mineral density with the menopause occurs later which could be a benefit for female participation in ultra-endurance swimming (2). Further, it is suggested that estrogen stimulate growth hormone which could prevent a loss of muscle mass and maintain the race performance (26). Supplementary, estrogen might increase the ventilator response and water retention which lead to a better oxygen exchange during performance and to save water during long-distance races (26). Additionally, female athletes are healthier, have a higher self-esteem and more academically successful than non-athletes (29). Further, it seems that females are motivated for an athletic participation by intrinsic or internal factors in contrast to male athletes who are motivated by external and extrinsic motives (29).

A further important finding was that the mean age of the finishers at the ‘Marathon Swim in Lake Zurich’ increased over the 23-years period. This coincides with previous findings reporting that the mean age in open-water endurance-swimmers was ~40 years (10, 11). Swimming causes fewer injuries than running or cycling (26) and therefore competitive swimming can be performed much longer in life into a higher age. In addition, body fat increases with increasing age which could be an advantage in long-distance swimming performance due to more buoyancy (26). Nonetheless, it is interesting that athletes with ~40 years are able to compete in ultra-swimming events although both slow and fast twitch fibers decline with age leading to a decrease in muscle power (26).

The age of the winners was ~27 years for both males and females. According to Tanaka and Seals (30), the best age of competing in swimming is between 25 and 40 years for males and between 30 and 35 years for females, respectively. This did not coincided with the findings of Issurin et al. (8) showing that the optimal age for the best swimming times in Olympians from the world-leading countries was 21.7 years for females and 23.2 years for males, respectively. The disagreement with the present study is probably caused by the fact that Issurin et al. (8) investigated high-level indoor pool swimmers participating in the Olympic Games and therefore had an intense pre-race preparation with a personal trainer for the Games. In contrast to our study, these non-elite open-water ultra-endurance swimmers had no professional preparation (10, 11).

A further finding was the faster performance for male swimmers compared to female swimmers and a relative stabilization of female and male ultra-swimmer performances during the 1987-2011 period. There are several explanations for the sex difference in swimming performance related to physiological and anthropometrical characteristics. Male athletes have a higher stroke volume and therefore the cardiac output is higher compared to female athletes (22). Further, the vascularisation of muscle mass is better in males because the blood volume is higher. All these facts result in a higher oxygen capacity for males. Also, the maximum oxygen uptake (VO_2max) is 15% to 25% lower in females compared to males (22). The higher VO_2max in male athletes could be an advantage in ultra-endurance swimming races and one reason why males are faster than females. Another explanation for the sex gap could be that male athletes have more androgen and more muscle mass than female athletes (22). Both a higher VO_2max and higher androgen levels are important for the higher strength in males compared to females.

The ultra-swimming performance remained stabled from 1987 to 2011 in both sexes. A reason could be that in swimming discipline no technological advances occurred because wetsuits were not allowed in the 'Marathon Swim in Lake Zurich'. In the present study, the mean sex difference in ultra-swimming performance for the winners was ~11% and remained unchanged across the years from 1987 to 2011. In contrast to our hypothesis, the sex difference in ultra-swimming appears similar to those observed for more traditional shorter swimming distances (19, 31). The sex difference in ultra-swimming performance seems lower compared to other ultra-endurance events. The males were ~11% faster than the female swimmers. At the 'Ironman Hawaii' triathlon covering 3.8 km swimming, 180 km cycling, and 42 km running, the sex difference in swimming was 10%, and 13% in both in the running and the cycling split (19). In contrast, Knechtle et al. (14) mentioned that in a Deca Iron ultra-triathlon covering 36 km swimming, 1,800 km cycling and 422 km running, males where

~45% faster in both the swimming and running split and ~40% faster in the cycling split compared to the female athletes. A possible explanation for the small sex difference in long-distance swimming compared to other endurance events could be that female athletes have more body fat than male athletes with 22% to 26% body fat for females and 13% to 16% for males, respectively (22). Another explanation could be the lower skeletal muscle mass in female open-water ultra-swimmers compared to male swimmers (34). Male ultra-swimmers have ~42 kg of skeletal muscle mass whereas female ultra-swimmers have ~29 kg of muscle mass. The difference of ~13 kg (~31%) might explain that male ultra-swimmers are faster compared to female swimmers. Finally, a difference in thermoregulation between males and females should also be considered (4, 31).

An interesting finding was that a higher age was associated with an increased risk not to finish the race. Also, the multilevel hierarchical regression analysis showed that both the age of the finishers and the water temperature had different effects on race outcome regarding the top three finishers and athletes placed behind the top three swimmers. In the top three finishers, sex, age and water temperature were all associated with swim performance times. For the athletes placed behind the top three swimmers, age and water temperature were not related to performance. Endurance performance decreases with increasing age (17, 30). The age of peak performance in ultra-endurance athletes extends to ~50 years for ultra-runners (17). For pool-swimmers, in both females and males, endurance swimming performance declined linearly from peak levels at age 35-40 years until approximately 70 years of age, whereupon performance declined exponentially thereafter (30).

The swim time was negatively associated with water temperature for the top three swimmers; the colder the water, the longer the swim time. For swimmers not placed in the top three, the swim time was not associated with water temperature. For all finishers, female sex was always highly significantly related to swim time. Body fat seems to be an advantage to stay longer in cold water such as 19 °C to 24 °C at the 'Marathon Swim in Lake Zurich' (1, 9, 12, 25) because fat mass is a better insulator than muscle mass (4). The higher body fat in females might improve their ability to compete longer in cold water. When female and male ultra-swimmers were compared, females had 31.3±3.6% body fat compared to 20.2±5.6% for males (10). Also, female swimmers have a higher mechanical efficiency compared with males (18). Also, the buoyancy increases with higher body fat and athletes should be more fatigue resistant. These aspects could be an advantage for competing in an ultra-endurance swimming race.

The present data showed that the participation in the longest lake open-water ultra-swimming in Europe has increased during the last 25 years. The 'Everest' of open-water ultra-swimming, the 35-km 'English Channel' seems of even higher interest regarding participation in the last decades (www.dover.uk.com/channelswimming/). The present findings may help athletes and coaches intending to prepare for the 'English Channel' even if the swim conditions in the 'English Channel' are different from a lake open-water swim. The participation and performance trends in the 'English Channel' swim need also to be analyzed in a future study.

PRACTICAL APPLICATIONS

The participation and the mean age of the male and female finishers at the 'Marathon Swim in Lake Zurich' increased during the 1987-2011 period. Despite an increase of the mean age of the ultra-swimmers during this period, the ultra-swimming performance remained stable for both sexes. The sex difference in ultra-swim performances of ~11% appears similar to those observed for shorter swimming distances but lower when compared to other ultra-endurance disciplines such as running. Higher age was associated with an increased risk for a failure in the race. Swim time was negatively associated with water temperature in the top three swimmers. The present results show that open-water ultra-swimming performance of elite swimmers over 26.4 km in a freshwater lake is affected by age, sex and water temperature. The sex difference in open-water ultra-swimming performance remained unchanged these last 25 years. The lower skeletal muscle mass in female open-water ultra-swimmers might explain this gender difference. For practical application, it seems unlikely that elite female swimmers will achieve the same performance of elite male swimmers competing in open-water ultra-swimming in water of ~20°C. Anthropometric and physiological characteristics such as skeletal muscle mass and thermal regulatory need additional investigations in females and males open-water ultra-swimmers.

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Female	359 min (2001)
Male	351 min (1993)
Sex difference	2.3%

Table 1: Female and male swimming time records of the 26-km 'Marathon Swim in Lake Zurich', Switzerland, and the corresponding sex difference.

Year	Water temperature (°C)	Weather	Air temperature at start (°C)	Air temperature at noon (°C)	Air temperature at evening (°C)
1987	22.8	Blue sky	17.6	22.8	19.1
1988	22.1	Blue sky	14.6	21.6	21.2
1989	16.2	Blue sky	14.7	21.8	16.8
1990	21.5	Blue sky	13.2	16.0	16.0
1991	22.0	Blue sky	16.5	22.6	21.8
1992	20.7	Blue sky	18.8	23.5	22.1
1993	19.6	Blue sky	17.5	24.1	21.3
1994	23.8	Blue sky	22.8	30.5	20.8
1995	21.8	Blue sky	19.1	27.7	25.4
1996	22.7	Blue sky	19.1	26.1	22.3
1998	21.4	Blue sky	20.6	30.3	27.7
2000	21.6	Blue sky	16.9	19.8	18.5
2001	22.8	Blue sky	20.2	27.1	22.9
2002	21.8	Blue sky	16.7	19.7	16.5
2003	25.9	Blue sky	21.3	28.9	29.0
2004	24.8	Blue sky	17.9	26.0	24.9
2005	21.6	Blue sky	16.2	21.5	18.2
2006	24.7	Rain	13.4	13.9	15.5
2007	21.5	Clouds	16.4	24.4	24.7
2008	23.0	Clouds	19.8	24.4	24.3
2009	21.6	Blue sky	15.4	21.8	22.5
2010	21.4	Rain	15.6	19.2	18.7
2011	20.0	Rain	14.9	18.9	15.4

Table 2: Water temperature, environmental conditions and air temperatures during race day. Water temperature of Lake Zurich, Switzerland, for all editions was provided by 'Amt für Abfall, Wasser, Energie und Luft' of Zurich (www.awel.zh.ch). Air temperature was provided by 'MeteoSchweiz' (www.meteoschweiz.admin.ch).

Swim time (min)				
Model 1: All finishers (*n*=436)	**ß**	***p***	**95% Conf. Interval**	
Female (male=0)	37.60	0.001	16.16	59.04
Age (years)	1.56	0.002	0.56	2.56
Temperature water (°C)	2.61	0.584	-6.72	11.95
ICC 7.3%		< 0.001		
Model 2a: Top three athletes (*n*=115)	**ß**	***p***	**95% Conf. Interval**	
Female (male=0)	44.16	0.000	25.71	62.62
Age (years)	3.15	0.000	1.85	4.45
Temperature water (°C)	-9.87	0.025	-18.51	-1.22
ICC 31%		< 0.001		
Model 2b: Athletes > top three (*n*=321)	**ß**	***p***	**95% Conf. Interval**	
Female (male=0)	60.27	0.000	35.82	84.72
Age (years)	0.38	0.464	-0.65	1.43
Temperature water (°C)	5.72	0.324	-0.56	17.11
ICC 10%		< 0.001		

Table 3: Results of the multilevel (hierarchical) regression analysis showing the effects of swimmer's characteristics and temperature on race time including race year as cluster variable for all finishers (Model 1), the top three swimmers (Model 2a), and the swimmers ranked behind the top three (Model 2b).

All participants (*n*=446)	**Odds ratio**	***p***	**95 % Conf. Interval**	
Female (male=0)	0.54	0.398	0.13	2.20
Age (years)	0.93	0.045	0.86	0.99
Temperature water (°C)	1.62	0.156	0.82	3.19
ICC 38%		0.03		

Table 4: Mixed-effect logistic regression analysis showing the odds ratios of swimmers' characteristics and temperature on finishing the race including race year as cluster variable.

Figure captions

Figure 1

The number of finishers in the 'Marathon Swim in Lake Zurich', Switzerland, from 1987 to 2011 increased significantly for both males ($r = 0.61$, $p < 0.001$) and females ($r = 0.77$, $p < 0.001$). Female finishers represented 32±14% of all finishers over the studied period.

Figure 2

Age of the male and female winners in 'Marathon Swim in Lake Zurich', Switzerland, from 1987 to 2011 (males: $r = 0.47$, $p = 0.03$; females: $r = 0.55$, $p < 0.01$) (Panel A). Changes in mean (±SD) age of the finishers for each sex in 'Marathon Swim in Lake Zurich', Switzerland, for the same period of time (males: $r = 0.66$, $p < 0.001$; females: $r = 0.83$, $p < 0.001$) (Panel B). The years analyzed are pooled and the mean age (±SD) of males and females is shown on the right side of the two panels (Total).

Figure 3

Swimming time of the male and female winners 'Marathon Swim in Lake Zurich', Switzerland, from 1987 to 2011 (males: $r = -0.01$, $p = 0.99$; females: $r = -0.12$, $p = 0.57$) (Panel A). Changes in mean (± SD) swimming time of the finishers for each sex in 'Marathon Swim in Lake Zurich', Switzerland, for the same period of time (males: $r = 0.18$, $p = 0.41$; females: $r = 0.29$, $p = 0.21$) (Panel B). The years analyzed are pooled and the mean time (±SD) of males and females is shown on the right side of the two panels (Total).

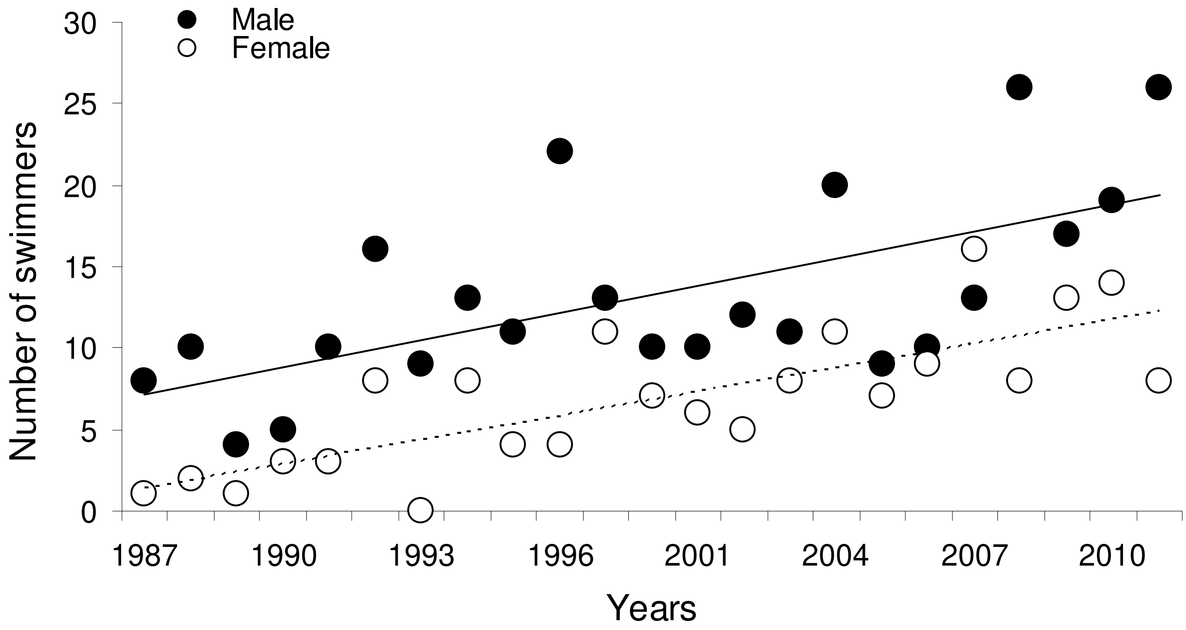
Male
Female
Number of swimmers
30
25
20
15
10
5
0
1987
1990
1993
1996
2001
2004
2007
2010
Years

Figure 1

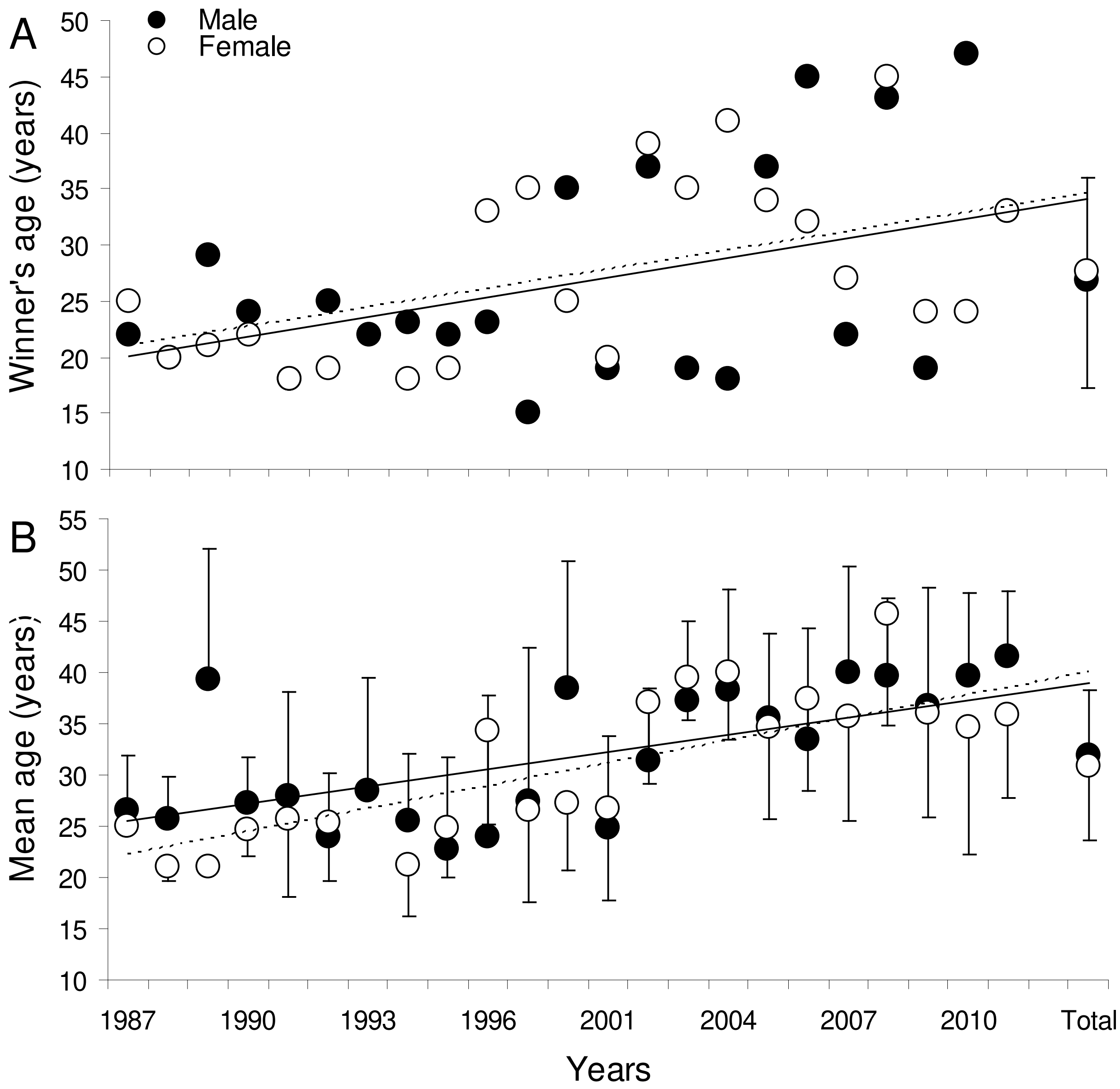
A
B
Male
Female
Winner's age (years)
Mean age (years)
50
45
40
35
30
25
20
15
10
55
1987
1990
1993
1996
2001
2004
2007
2010
Total
Years

Figure 2

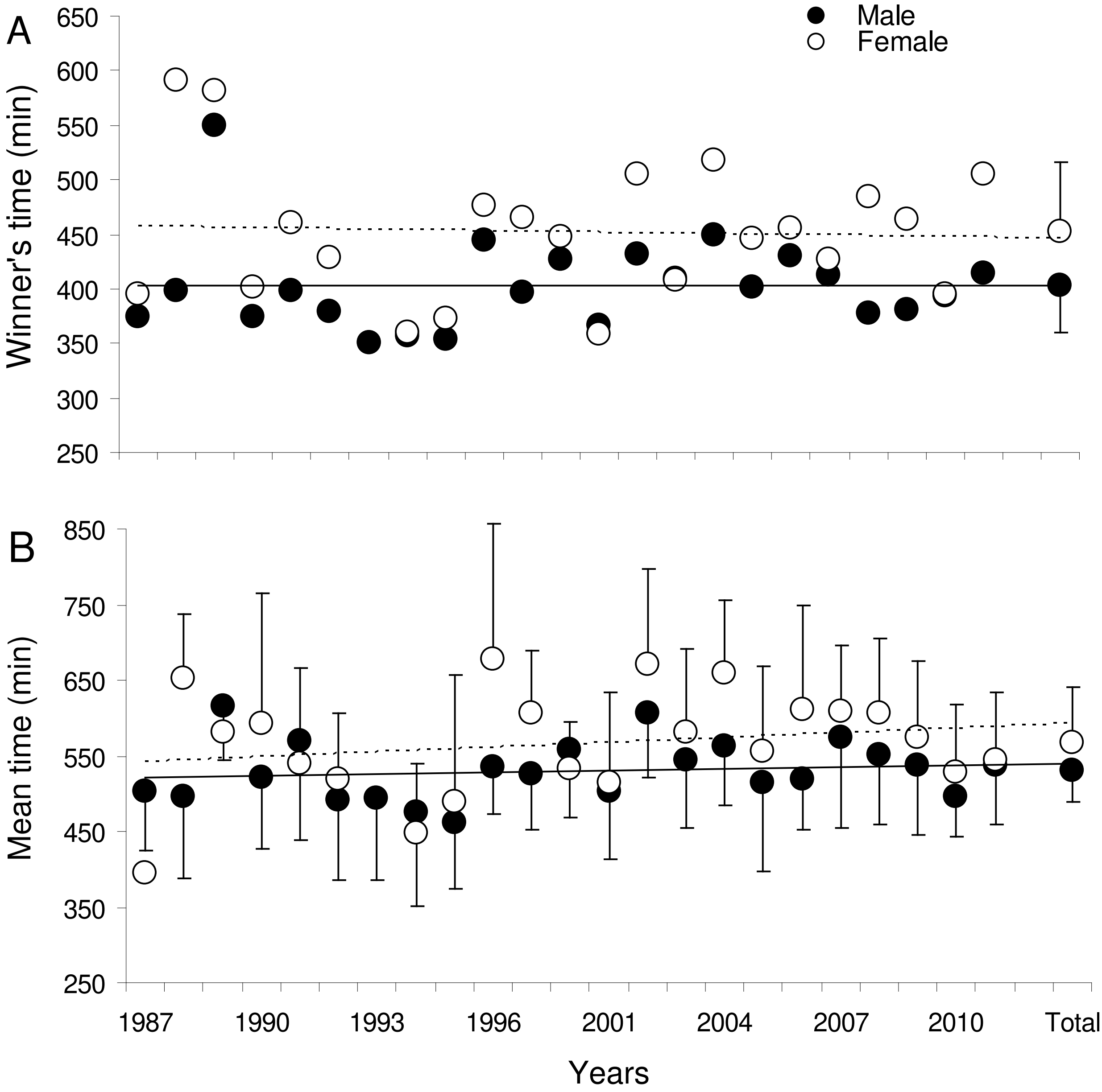
A
B
Male
Female
Winner's time (min)
Mean time (min)
650
600
550
500
450
400
350
300
250
850
750
650
550
450
350
250
1987
1990
1993
1996
2001
2004
2007
2010
Total
Years

Figure 3